# Space Weather Technical Forecast

Issued on Thursday, 02 December 2021 at 12:45 Local

**This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales**

**Space Weather Forecast Headline: Chance of G1/Minor Storm activity.**

**Analysis of Space Weather Activity over past 24 hours**

**Solar Activity:** Solar activity was very low, with no significant flares detected. There are currently three sunspot regions visible, with 2898 (Hsx/Alpha) and 2900 (Dao/Beta) in the southwest, both showing little overall change in the period. AR2902 in the northwest has shown some growth and hinted at an increase in magnetic complexity, it is being closely monitored but the penumbra remain rudimentary and no increase in flare activity has been observed so it remains a Dri/beta classification. No Earth-directed CMEs were seen in available imagery.
**Solar Wind / Geomagnetic Activity:** Solar winds, as measured by DSCOVR at L1, have fluctuated significantly through the period with brief peaks near 570 km/s, however the mean value near 500 km/s has not changed. Density was at average levels. Total IMF (Bt) was largely weak below 8 nT, with its north-south component (Bz) ranging between +5/-6 nT but often negative/southward pointing. Phi angle was predominantly in a positive orientation (away from the Sun). Resultant geomagnetic activity was mostly at Unsettled levels (Kp 3) with an Active (Kp 4) interval between 01/2100-2359 UTC.
**Energetic Particles / Solar Radiation:** The high energy proton flux (greater than 10 MeV) remained at background levels. High energy electron flux (greater than 2 MeV) as observed by GOES-16 reached high levels 1090 pfu at 02/1055 UTC, though levels soon dropped back below 1000pfu so an Electron Flux Alert was not triggered. The associated 24-hour integrated fluence remained below the Active threshold (1e8 integrated pfu), though with an increasing trend. Observed fluence at 02/0000 UTC was 9.659e6 integrated pfu.

**Four-Day Space Weather Forecast Summary**

**Solar Activity:** Solar activity is likely to remain predominantly very low, with a chance of C-class flares, primarily from AR2902 which has recently shown some growth.
**Solar Wind / Geomagnetic Activity:** Continued enhancements from various coronal hole high speed streams are expected through the period, including CH26/+ initially on day 1 (2nd), then CH27/+ likely later on day 1 or during day 2 (2nd or 3rd), with lingering effects lasting into day 3 (4th), followed by a further possible connection with CH28/+ by day 4 (5th). A filament eruption which left the Sun on the 29th, may also bring a brief enhancement to solar winds during day 1 (2nd) from a glancing blow. Geomagnetic activity is expected to be mostly Unsettled, but with some Active spells, and a chance of G1/Minor Storm intervals.
**Energetic Particles / Solar Radiation:** The high energy (greater than 10 MeV) proton flux is expected to remain at background levels. The high energy electron flux (greater than 2 MeV) is showing a rising trend and an increasing likelihood of diurnal maximums reaching high levels for much of the rest of the period. The associated 24 hour integrated fluence is also expected to show a rising trend, with an increasing likelihood of reaching the Active threshold (1e8 integrated pfu) as the period progresses.

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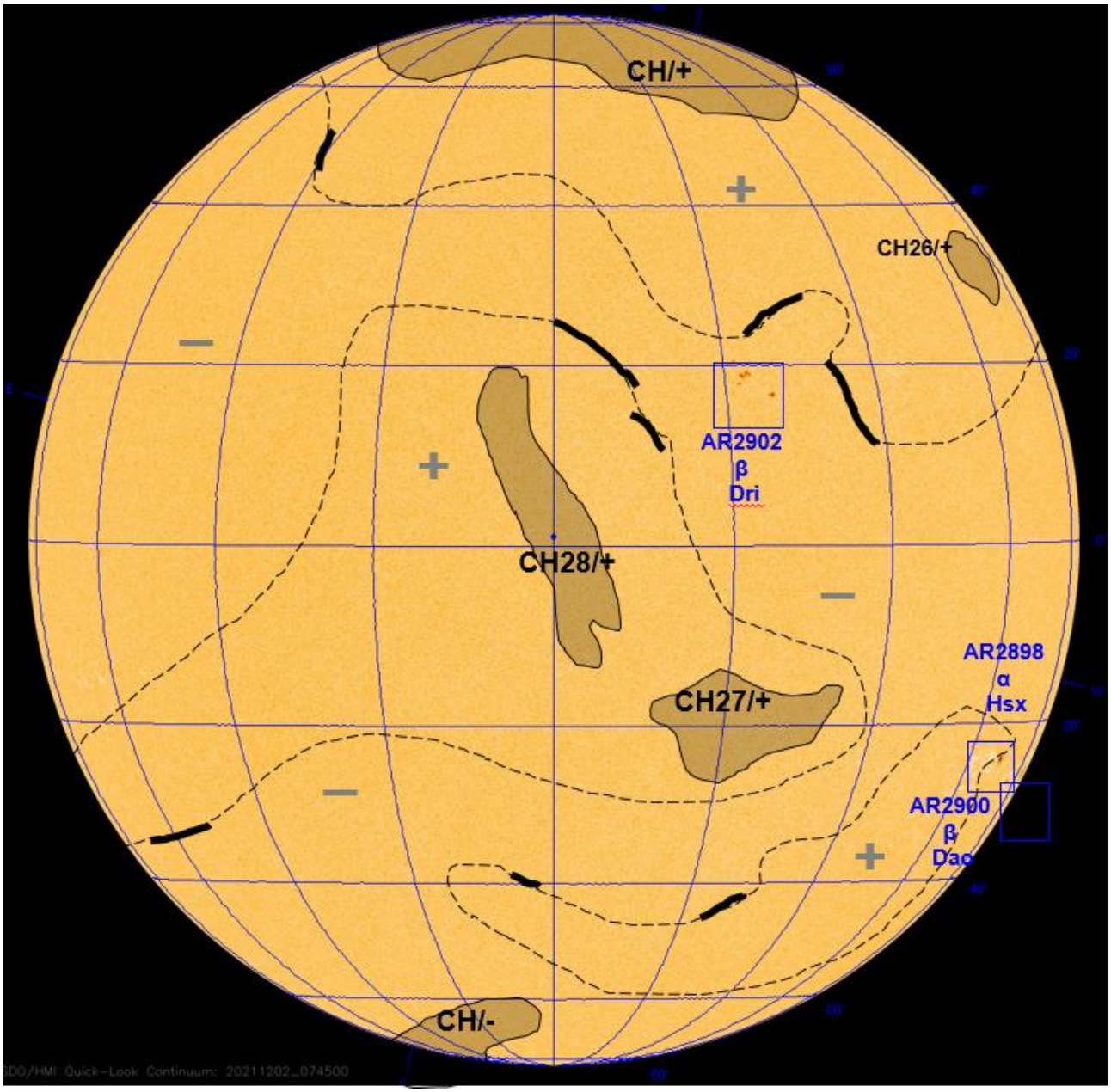
**Figure 1. Solar Analysis Valid 02/0800UTC.**

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**Key:** Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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## Geomagnetic Storms:

A filament eruption which left the south centre disc of the Sun on the 29th may bring a brief enhancement to solar winds during 2nd December with a possible glancing blow, though the majority of the ejecta is expected miss the Earth. There are no other Earth directed CMEs in the forecast.

The solar wind parameters indicate connection with CH26/+ HSS continues. CH27/+ appears to be a more notable feature, and whilst its high speed stream is not expected to arrive until late on the 2nd or 3rd December, there is the potential for a strong solar wind (perhaps near 700 km/s, which has been observed from some coronal holes in the southern disc during the last month). Enhanced observed solar winds from STEREO-A on 29th may also indicate potential faster solar winds from this feature reaching Earth late on the 2nd or 3rd December. CH28/+, which was in previous days the rearward extension of CH27/+, is likely to become geoeffective by the end of the period, continuing the coronal hole influences on the near Earth space environment. Consequently geomagnetic activity is expected to be mostly Unsettled, but with Active spells likely and a chance of G1/Minor Storm intervals, these most likely on 2nd and 3rd Dec, and perhaps the 5th.

| Geo-Magnetic Storm Probability (Exceedance) | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| Minor or Moderate | G1 to G2 | No | 50 | 50 | 40 | 40 |
| Strong | G3 | No | 1 | 1 | 1 | 1 |
| Severe | G4 | No | 1 | 1 | 1 | 1 |
| Extreme | G5 | No | 1 | 1 | 1 | 1 |

## Geomagnetic Activity - Earthbound Coronal Mass Ejections

| Date/time 21.5R (UTC) | Halo: Full or Partial | Source | Source Location | Estimated Speed | Estimated Arrival Time | Comments |
|---|---|---|---|---|---|---|
| 29/1553UTC | / | Filament eruption | South centre disk | 570km/s | 02/1800UTC +/- 12 hrs | Mostly below Earth but glancing blow possible. |

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# Met Office Space Weather Technical Forecast

## Radio Blackouts - X-Ray Flares:

Flare activity is currently very low, with any enhancement to the X-ray flux most likely from ARs 2898 (Hsx/Alpha) and 2900 (Dao/Beta) in the southwest, although both likely to rotate around the west limb through this forecast period. AR2902 (Cro/Beta) in the northwest remains relatively simple with only rudimentary penumbra. Finally, far side data would suggest no significant regions expected to move into view around the east limb during this period.

Solar activity is likely to remain low or very low, with a chance of C-class flares, and a very slight chance of an M-flare.

| X Ray Flares<br>Probability | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC)<br>(%) | Day 2 (00-24 UTC)<br>(%) | Day 3 (00-24 UTC)<br>(%) | Day 4 (00-24 UTC)<br>(%) |
|---|---|---|---|---|---|---|
| Active | R1-R2 M Class | No | 5 | 5 | 5 | 5 |
| Very Active | R3 to R5 X Class | No | 1 | 1 | 1 | 1 |

## Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as observed by GOES-16 is forecast to remain at background levels, with no solar radiation storms anticipated.

| Radiation Storms<br>Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $s^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC)<br>(%) | Day 2 (00-24 UTC)<br>(%) | Day 3 (00-24 UTC)<br>(%) | Day 4 (00-24 UTC)<br>(%) |
|---|---|---|---|---|---|---|
| Active | ≥ S1 | No | 1 | 1 | 1 | 1 |
| Very Active | ≥ S3 * | No | 1 | 1 | 1 | 1 |
| * S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$) | | | | | | |

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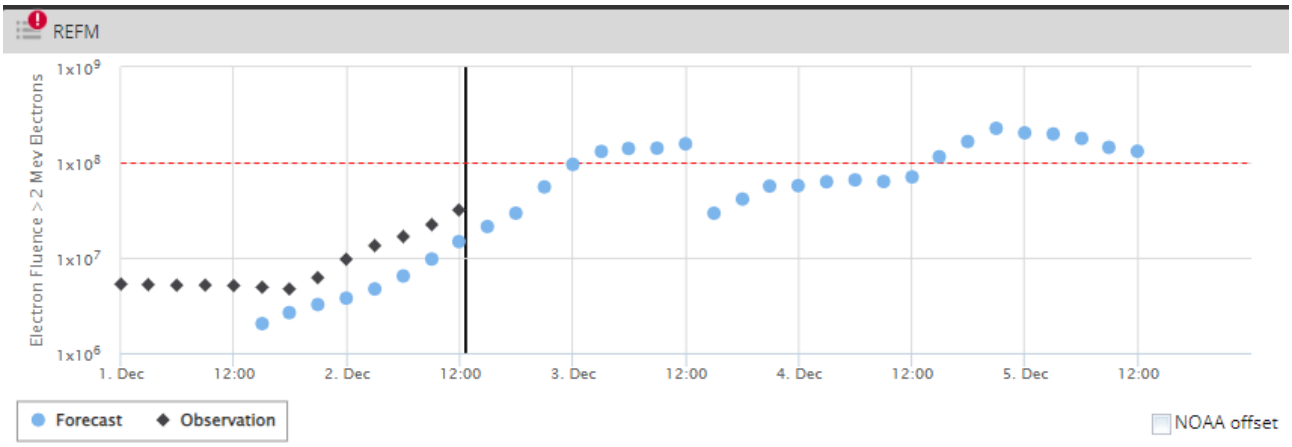
**High Energy Electrons Event (≥ 2MeV):**

The high energy (greater than 2 MeV) electron flux as observed by GOES-16 at GEO has been at background to moderate levels during the last 24 hours, but is now on a rising trend after connection to a faster stream of solar wind. Another potential enhancement is likely to be from the faster wind of CH27 later on day 1 (2nd), with an increasing likelihood of diurnal maximums reaching high levels for much of the rest of the period.

The associated 24 hour integrated fluence is also expected to show a rising trend, with an increasing likelihood of reaching the Active threshold through the period. This is supported by REFM which also reflects this trend, and forecasts Active fluence levels perhaps by day 3 (4th).

| GEO Electron Environment<br>Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $day^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC)<br>(%) | Day 2 (00-24 UTC)<br>(%) | Day 3 (00-24 UTC)<br>(%) | Day 4 (00-24 UTC)<br>(%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ 2 MeV ≥ $1x10^8$** | No | 5 | 20 | 40 | 50 |
| **Very Active** | **≥ 2 MeV ≥ $1x10^9$** | No | 1 | 1 | 1 | 1 |

**Figure 2: MOSWOC Relativistic Electron Fluence Model is forecasting an increasing trend with the 1e8 Alert Level likely to be breached.**

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